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CHEMICAL & ENGINEERING

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Textile imports hurting fiber intermediates

A Key Chemicals Review
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■ **New software makes it possible to develop foam parts in half the time previously required.** **Page 5**

■ **EPA issues an immediate ban on insecticide dicofol produced by Rohm & Haas.** **Page 6**

■ **Oncor offers blood test that uses a radioactive label to detect AIDS virus.** **Page 6**

Cover: Robot at Du Pont's Seaford, Del., plant packs nylon fiber for shipment

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Science

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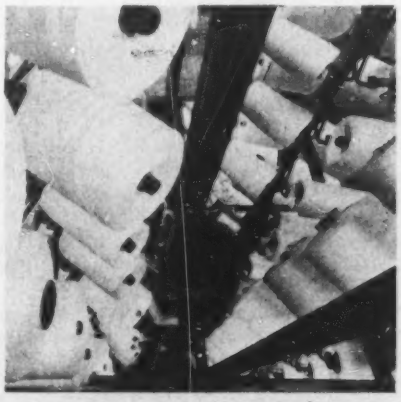
Awards

ACS award winners: Angyal, Arcos, Bartok, Battista, Berson, Beynon, Drickamer, Hall, and Heine. **Page 33**



Business

Growth of fiber intermediates DMT/PTA and cyclohexane is hampered by apparel imports and slowed exports. Production of ethylene oxide is likely to decrease because of decline in demand. **Page 11**

Fiber Intermediates Demand Dampened by Apparel Imports

Little growth in U.S. output of major intermediates DMT/PTA and cyclohexane expected this year; ethylene oxide production may decline

Bruce F. Greek, C&EN Houston

Imports of apparel made with polyester and nylon fibers continue to limit U.S. production of textiles of the same fibers and thus are dampening growth in U.S. production of those fibers and the intermediates used to make them. More dimethyl terephthalate (DMT), purified terephthalic acid (PTA), and cyclohexane will be produced this year because of increased demand for exports and inventory building, but not because of higher production of synthetic fibers.

Production of the other major fiber intermediate—ethylene oxide—likely will decrease because the decline in its demand for making polyesters will more than offset any small growth in its demand for making antifreeze. Ethylene oxide is used to make fiber-grade ethylene glycol; ethylene glycol together with DMT/PTA gives polyester—poly(ethylene glycol terephthalate) (PET).

Unless apparel imports can be held at current levels, the outlook for growth in production of DMT/PTA, cyclohexane, and ethylene oxide is uncertain. But even if apparel imports level off, DMT/PTA and ethylene oxide production probably will fall. A decline in polyester consumption also could result from increased use of cotton in apparel, either alone or blended with polyester fiber, because prices for cotton are low as a result of efforts to spur exports and use up U.S. cotton supplies.

Key Chemicals

Exports of DMT/PTA now are growing less rapidly and are expected to decline as capacity to make the polyester intermediates grows in Asia. Polyester fiber exports could decline faster than U.S. uses grow, if apparel imports are limited to allow normal growth in U.S. consumption of polyester fibers. It is more likely, however, that apparel imports will rise despite various efforts to limit them and that exports of DMT/PTA will decline in the late 1980s.

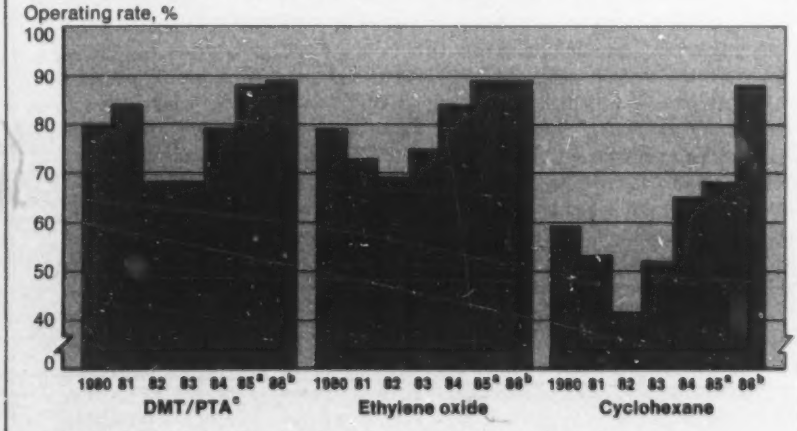
Growth in polyester bottle resins could partly offset the effect on DMT/PTA of imported apparel and decline in exports. Demand for these resins has risen at rates below some of the very rosy forecasts, but still at good rates.

Most of these resins are of the PET type, which pulls ethylene oxide along as well. Forecasts for bottle resins continue to call for 10 to 25% year-to-year growth rates and substantial volume growth. Many of those forecasts also have a proviso that if technological developments lead to hot-fill capability, better vapor barriers, and other improvements in volume-produced bottles and other containers, then growth in demand could be even higher.

Other polyester resins (especially the butylene form) are being developed by several companies to be made into a host of fabricated products other than containers. These engineering resins, and nylon engineering resins as well, could further make up for declines in demand for DMT/PTA and cyclohexane because of slipping U.S. fiber demand.

For some details of the near-term outlook for these major-volume fiber intermediates, please see the following pages.

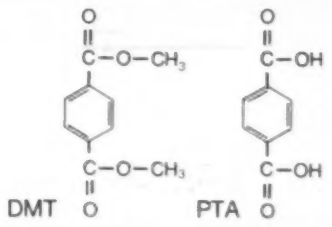
Operating rates have pushed close to 90%



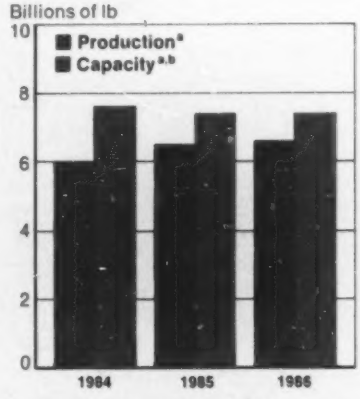
a Preliminary. b Estimated. c PTA capacity and production converted to DMT equivalents.
Sources: International Trade Commission, C&EN estimates

DMT/PTA

- ***Demand stronger***
- ***Capacity on hold***
- ***Prices off slightly***



PRODUCTION/CAPACITY



a DMT and DMT equivalents of PTA (1.0 lb of PTA = 1.17 lb of DMT). b First quarter.

MAJOR PRODUCERS

Amoco Chemical, Cape Industries, Du Pont, Eastman Chemical

HOW MADE

Oxidation of p-xylene to make PTA; oxidation of p-xylene and concurrent esterification with methanol to make DMT

MAJOR DERIVATIVES

Poly(ethylene terephthalate) 90%, poly(butylene terephthalate) 5%

MAJOR END USES

Polyester fibers 65%, bottles 15%, films 15%, engineering resins 5%

FOREIGN TRADE

Exports—rising to more than 1.3 billion lb, imports—negligible

PRICES

About 26 cents per lb for DMT and 28 cents per lb for PTA

Strong exports of dimethyl terephthalate (DMT) and purified terephthalic acid (PTA) in 1986 likely will boost production of those polyester materials despite a lackluster performance by polyester fibers, their major use. Other applications of DMT and PTA—polyester bottles, films, and engineering resins—will add to growth this year. Of these, bottles is the largest use, but they account for only about 15% of total DMT/PTA consumption.

As the third quarter ends, estimates of DMT/PTA total production for this year cluster around 6.6 billion lb, up less than 200 million lb from estimated 1985 output. (Estimates are based on DMT production plus PTA production converted to DMT equivalents in the ratio 1.17 to 1.) Forecasts for increased output are based on exports holding up in the fourth quarter, or increasing slightly, and polyester fiber consumption remaining at about the same level as earlier this year, down 2 to 3% from 1985. Demand for bottle resin, expected to rise 10 to 15% during 1986, will contribute to the higher output of DMT/PTA by requiring as much as 100 million lb more material than it did last year.

Capacity to make DMT/PTA remains on hold at 7.4 billion lb. That includes PTA converted to DMT equivalents. Because of scrapping of a previously mothballed plant, however, capacity is lower than two years ago. Other than minor debottlenecking work, no capacity expansions are in the works. Consequently, if 1986 production of DMT/PTA totals 6.6 billion lb, U.S. capacity will be run at an average rate of 89% of nameplate, which is definitely higher than in recent years.

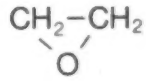
Nevertheless, this higher rate remains below a level necessary to create a tight supply in the polyester industry. It also remains low enough that prices have weakened during 1986. Part of that slack stems from consumers' expectation of a pass-through of the lower feedstock costs of *p*-xylene and methanol. Declines in demand for polyester fibers among U.S. textile makers also are responsible. The declines result from increased imports of apparel containing polyester fiber and from a shift toward higher use of cotton in blends with polyester because of a large drop in cotton prices.

Exports of DMT/PTA, at more than 20% of U.S. output, will rise less than they did last year. Exports this year could reach 1.4 billion lb, up from about 1.3 billion lb in 1985 and less than 900 million lb in 1984. However, 1986 may be the last year for a gain in exports and higher U.S. production of DMT/PTA, because of worldwide capacity expansions, especially in the Pacific Rim nations.

DMT/PTA consumption in the U.S. is about 5.2 billion lb. Roughly two thirds (or 3.4 billion lb) eventually end up in a fabricated product containing polyester fiber. The apparel market, which continues to be battered by imports, takes the largest share of polyester fibers. Home furnishings are next in size and also are affected by imported finished products, although to a lesser degree than the apparel market. Industrial uses of polyester fibers are varied. Tire cord is a major part of the market, although that use has been reduced by use of other fibers in longer-lasting radial tires, the trend toward smaller-sized tires, and growing imports of replacement tires.

Because demand for bottle resins and other packaging forms is growing both in the U.S. and for export, those resins continue to be the bright spot for DMT/PTA. Capacity expansions for these resins are under way by several producers, and demand for DMT/PTA in packaging uses could reach 800 million lb this year.

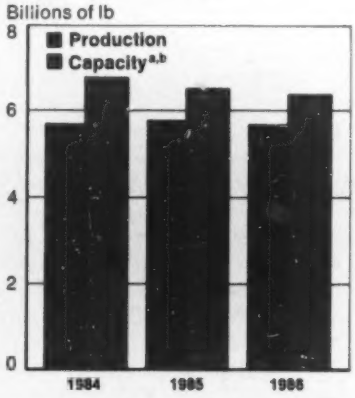
The other significant polyester end uses of DMT/PTA are film and molding resins. Most film resins are the ethylene form, and most molding or engineering resins are the butylene form. Together the resins could require 1 billion lb of DMT/PTA this year, as a result of about 5% growth.



Ethylene oxide

- **Demand weak**
- **Capacity lower**
- **Prices down**

PRODUCTION/CAPACITY



a First quarter. b Some capacity reported mothballed not included.

MAJOR PRODUCERS

BASF Wyandotte, ICI Americas, Shell Chemical, Texaco Chemical, Union Carbide

HOW MADE

Vapor-phase oxidation of ethylene with oxygen

MAJOR DERIVATIVES

Ethylene glycol 60%; ethoxylates 10%; ethanolamines 10%; di-, tri-, and polyethylene glycols 10%

MAJOR END USES

Polyester fibers, films, and molded items 25%; antifreeze 30%; surfactants 15%; solvents 15%

FOREIGN TRADE

Exports—tiny, falling to less than 25 million lb; imports—negligible

PRICE

About 25 cents per lb (merchant sales are only 10% of production)

Growth in ethylene oxide production is stymied by imports of apparel containing polyester fibers and by lack of growth in demand for antifreeze. Ethylene oxide's major derivative—glycol—is a key ingredient in polyester fibers and antifreeze. Glycol consumes more than 60% of U.S. ethylene oxide output, reflecting the significance of these uses to the outlook for ethylene oxide. Other uses for ethylene oxide aren't seriously affected by imported end products. Those uses, however, are growing slowly and will affect ethylene oxide growth only modestly.

The weak growth in the dominant uses of ethylene oxide will hold production stagnant at 5.7 billion to 5.8 billion lb again this year, down slightly from the peak 5.83 billion lb produced in 1985, according to preliminary estimates. Output last peaked in 1979 when it was slightly less than 5.7 billion lb. In the early 1980s, production slipped to less than 5 billion lb and did not rise again until 1983.

U.S. ethylene oxide capacity peaked in 1983 at nearly 7.3 billion lb and has fallen since then to about 6.4 billion lb, excluding some capacity not expected to be used again. Prospects for capacity expansions, other than minor debottlenecking, are slim because of the current overcapacity and the outlook for slow growth in the various end uses. With prospects for a small decline in output this year, nameplate capacity will be operated at a rate of about 89%. That rate is higher than in recent years because of shutdowns of capacity.

Because exports are small relative to total production, nearly all ethylene oxide produced is consumed in U.S. end-use markets. The net of exports over imports of ethylene glycol, however, provides the equivalent of exporting some 200 million lb of ethylene oxide. Other derivatives of ethylene oxide (such as ethanolamines) have net exports and provide additional export equivalents. Nevertheless, derivatives going to export account for only 5 to 10% of ethylene oxide consumption.

Less than 10% of ethylene oxide production is sold. Nearly all producers use it captively to make various derivatives. They do sell some ethylene oxide when their needs for use in derivatives are below incremental production.

More than 90% of the glycol made from ethylene oxide goes to two uses, antifreeze and polyester resins. The split between those two markets currently is about 50-50. If bottle resins continue to give a boost to polyesters as they have during the past few years, polyesters will become the largest use of ethylene glycol and, in turn, of ethylene oxide.

Changes in automobile and truck sizes have slowed growth in antifreeze demand during the past decade. Cars with smaller engines substantially reduce antifreeze initial-fill volumes. Moreover, rapid growth in sales of imported cars during the beginning of this decade further reduced initial-fill demand.

Antifreeze replacement demand also has fallen off because of the smaller-sized radiators. Outlook for the antifreeze market for ethylene oxide remains one of low growth, at about 1% annually for the remainder of this decade.

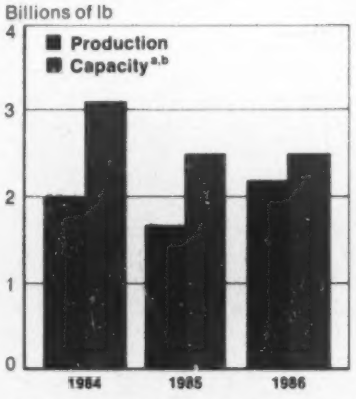
Other glycols account for less than 10% of ethylene oxide use. They go into a variety of end uses, such as intermediates for some specialty chemicals and solvents. Because of their varied end uses, growth is difficult to forecast but probably will be 2 to 4% annually.

Ethanolamines, various ethoxylates, and glycol ethers account for most of the remaining consumption of ethylene oxide. Those are largely intermediates for various end products used as detergents, solvents, and power transmission fluids. Demand for ethylene oxide in those uses also is forecast to grow 2 to 4% annually.

Cyclohexane

- ***Output recovering***
- ***Capacity varying***
- ***Prices unstable***

PRODUCTION/CAPACITY



a First quarter. b Some capacity shut down and may not be restarted.

MAJOR PRODUCERS

Chevron, Phillips, Sun, Texaco, Unocal, Champlin

HOW MADE

Catalytic hydrogenation of benzene; recovered from natural gasoline

MAJOR DERIVATIVES

Adipic acid 60%, caprolactam 30%

MAJOR END USES

Nylon 66 60%, nylon 6 30%

FOREIGN TRADE

Exports—rising to near 300 million lb, imports—holding at less than 10 million lb

PRICE

About 90 cents per gal

Cyclohexane supply has become tighter for consumers of this nylon intermediate. Operating capacity to make cyclohexane has declined, reducing output as demand for nylon fibers enters a seasonal upturn. Cyclohexane prices likely will rise with the tightening supply, but it is uncertain whether they will rise more than expected from the increased price of benzene, which along with hydrogen is the basic raw material for cyclohexane.

Production of cyclohexane will rise substantially this year to about 2.2 billion lb from 1.7 billion lb in 1985. All of the 1986 production may not be used. Some of it likely will go into inventories drawn down during 1985. Growing exports are expected to take 50 million to 100 million lb more than the 228 million lb exported in 1985.

Capacity to make cyclohexane (mainly by hydrogenation of benzene) totaled about 2.5 billion lb at the beginning of this year. During the third quarter, Du Pont stopped production because the company had shut down the chlorine-caustic soda unit adjacent to its cyclohexane unit at Corpus Christi, Tex., and no longer had a supply of hydrogen. That cyclohexane unit has a nameplate capacity of about 325 million lb per year. Earlier this year, Chevron shuttered a smaller cyclohexane unit at Port Arthur, Tex. However, in June, the Chevron plant was restarted and continues to operate. Units of Phillips 66, which recover cyclohexane from natural gasoline, are run at varying production rates depending on the quantity of cyclohexane in gasoline fed to the plants. The North American cyclohexane supply also has been reduced by the shutdown of a plant in Canada.

If cyclohexane output totals 2.2 billion lb during 1986, the nameplate operable capacity will be run at an average of 88%. However, if nearly 200 million lb of 1986 capacity is removed from the nameplate total because of the unusually lengthy shutdowns, then the operating rate will jump to more than 95%. That level of operation is about full out because cyclohexane units are noted for frequent, brief shutdowns because of minor operating problems.

Current operating rates provide a better climate for producers than the one five years ago when rates ranged from 50 to 60% of nameplate capacity. Those low rates and very competitive pricing led some producers to leave the business during the early 1980s.

High operating rates depend mainly on the nylon business and, to a lesser degree, on exports. Cyclohexane has few uses other than as an intermediate for making adipic acid for nylon 66 or caprolactam for nylon 6. The main nonnylon uses are as a solvent or in making cyclohexanone (also used as a solvent) and account for less than 5% of U.S. consumption. None of those solvent or other minor uses are growing much and will have minimal impact on cyclohexane demand this year.

The use of cyclohexane in nylon divides about 2 to 1 between nylon 66 and nylon 6. About 10% of adipic acid production goes to make other products, such as specialty polyurethanes and plasticizers for polyvinyl chloride, as well as several small-volume miscellaneous chemicals. A small amount (less than 2%) of caprolactam is used in miscellaneous products. None of those nonnylon uses are growing much and will not have any significant effect on demand for cyclohexane in 1986.

Nylon fiber production inched up during the early part of this year as producers kept tight reins on inventory growth. Apparel use of nylon fibers is being hit by imports of finished products, but carpet use remains relatively immune from the effects of imports. Rising home sales during the first half of this year have helped nylon carpet sales and, in turn, nylon production. A larger share of nylon 6 goes into carpets than does nylon 66. Hence this nylon form is even less affected by imports of finished nylon products.